

The pbalance (poor man’s balance) package*

Nelson Lago
lago@ime.usp.br

<https://gitlab.com/lago/pbalance>

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Abstract

This package tries to *safely* make the columns on the last page of a two-column document have approximately the same height. It should “just work” without user intervention, which is particularly useful for class authors, but also offers the user a command to control the result. There are, however, three caveats:

1. Results are adequate, but often not optimal;
2. In some cases, the package may give up (the document is generated correctly but the last page is not balanced);
3. The package demands additional \LaTeX passes.

1 Introduction and usage

First things first: this package is a **hack**. It is also **beta** quality. However, I believe it is *safe*, i.e., it should not generate incorrect output.

In a two-column document, it is desirable for the columns in the last page to have the same height (the columns should be “balanced”). Two packages (`balance` and `flushend`) try to provide this in \LaTeX , but both may generate defective output in some circumstances. This package tries to solve this problem.

Balancing is often not possible: imagine a document with an odd number of lines on the last page, or with ten lines of text together with an image that takes the height of fifteen lines of text, or a document where making columns the same height would leave a sectioning command at the bottom of the first column etc. Since such cases happen often, we consider it enough for the columns to be “not too unequal”, even when equal heights might be possible (the algorithm cannot deliver better results and, in fact, striving to make columns exactly the same height with it may sometimes yield poor results, so we do not even try).

*This document corresponds to pbalance v1.0, dated 2020/12/03.

To use the package, add `\usepackage{pbalance}` to the preamble and things should “just work”. However, the document will take more \TeX passes to compile, and minute changes to it that would normally need one additional \TeX pass will likely need three.

If the last page does not have floats, footnotes, or marginpars, the package simply uses `\balance`, from the `balance` package; otherwise it uses its own algorithm. You may instead use `\shrinkLastPage{some-measurement}` to manually define how much shorter the first column of the last page should be. This, however, will not eliminate the need for extra passes (the package needs to find out which page is the last).

2 How does it work

This package works on two fronts:

1. It uses a \TeX pass to gather information: which is the last page? Does it have floats? Footnotes? How much free space in each column?
2. It uses this information in a subsequent pass to balance the last page. If there are no floats or footnotes, it uses the `balance` package; otherwise it uses the measurements collected to shrink the first column (using `\enlargethispage`) by a “reasonable” amount.

If measurements change between passes, this means the document was edited, so we forget the previously gathered data and start over. However, the package cannot detect changes that happen between the “collect data” pass and the “balance for the first time” pass: it has to assume that any change at this point is caused by the fact that we started balancing (it can, however, detect if the last text page changed; if this happens, we give up balancing). If the change is small, that is acceptable: we are not aiming at balancing perfectly anyway. If it is a big change (for example, the addition of the bibliography block), results will suffer.

To prevent this, it would be ideal to only start the process after all passes needed to stabilize the document have run. In practice, however, this would be too hard to detect. What we do instead is simply wait for two consecutive passes to result in columns of the same size in the last page. When this happens, we proceed to balance in the next pass and assume (quite reasonably) that, as long as the document is not modified, the effect of further passes in the last page is small, so ignoring it disturbs the balancing only slightly¹.

3 TODO / wish list

Some useful stuff we should consider implementing:

- add `\if@twocolumn` tests to prevent crashes and other problems;
- add options to (1) allow using the `balance` package on pages with floats and (2) completely disable the `balance` package;

¹Like I said on the introduction: this package is a hack.

- make the mechanism able to work with any page, not just the last, and with more than one page at once. This is useful for book chapters, for example;
- on top of that:
 1. create command to manually indicate the page numbers to balance
 2. create command similar to `\balance` from the `balance` package
 3. allow user to set manual balancing for each page independently

4 The implementation

We define `\@PBlastPage` using `zref-abspage`; It is the page number for the last page of text. This might *not* be the last page of the document: there may be one or more float pages after it. Still, it *is* the page we want to balance. We do not act on it, however; instead, we save its value to the aux file as `\@PBprevLastPage` and proceed to balance on the next \LaTeX pass.

We also define two toggles:

@PBstabilized There have been a few passes already and the document has apparently stabilized.

@PBimpossible We tried to balance on a previous pass and failed.

4.1 Initialization, required packages etc.

Besides some other required packages, here we load the `balance` package; if there are no floats or footnotes involved, we will simply use it. We need to load it after we modify `\@outputdblcol`, so we use `\AtEndOfPackage`.

We also define the `draft` option, which disables processing.

```

1
2 \RequirePackage{etoolbox}
3 \RequirePackage{expl3}
4 \RequirePackage{atbegshi} % Manipulate the page output routine
5 \RequirePackage{atveryend} % Write to the aux file after processing ends
6 \RequirePackage{zref-abspage} % Figure out the current page
7
8 \AtEndOfPackage{\RequirePackage{balance}}
9
10 % See https://github.com/latex3/latex2e/issues/399#issuecomment-703081793
11 \gdef \@reinserts{%
12   \ifvbox\@kludgeins\insert\@kludgeins
13     {\unvbox\@kludgeins}\fi
14   \ifvoid\footins\else\insert\footins{\unvbox\footins}\fi
15 }
16
17 \providetoggle{@PBstabilized}
18 \providetoggle{@PBimpossible}
```

```

19
20 \newtoggle{@PBdraft}
21 \DeclareOption{draft}{\toggletrue{@PBdraft}}
22 \ProcessOptions\relax
23

```

4.2 The balancing front

The basic balancing process is reasonably simple: right before each new page, check whether it should be balanced. If so, add the adequate code to the top of the page (either call `\balance`, from the `balance` package, or add `\enlargethispage`).

```

24
25 % Right before the first page
26 \AtBeginDocument{
27   \@PBifShouldBalanceNascentPage
28     {\@PBstartBalancing}
29   {}
30 }
31
32 % Right before all other pages
33 \AtBeginShipout{
34   \@PBifShouldBalanceNascentPage
35     {\@PBstartBalancing}
36     {}
37 }
38
39 \newcommand\@PBifShouldBalanceNascentPage[2]{
40   \ifboolexpr
41     {
42       togl {@PBdraft}
43       or not togl {@PBstabilized}
44       or test {\ifdefvoid{\@PBprevLastPage}}
45     }
46     {#2}
47     {
48       % abspage refers to the finished page, not the nascent page
49       \ifnumcomp{\@PBprevLastPage - 1}={}\value{abspage}}
50       {#1}
51       {#2}
52     }
53 }
54
55 % Let's give the user a chance to manually define what to do
56 \newcommand\shrinkLastPage[1]{\dingdef\@PBslack{#1}}
57
58 \newcommand\@PBstartBalancing{
59   \ifdefvoid{\@PBslack}
60     {\@PBautomaticBalance}
61     {\@PBshrinkPage}

```

```

62 }
63
64 \newcommand\@PBautomaticBalance{
65   \@PBifBalancePossible
66   {
67     \@PBifBalancePkgPossible
68     {\balance} % easy peasy, use the balance package
69     {
70       \@PBifPoorBalancePossible
71       {
72         % use the poor man's balance algorithm
73         \@PBcalculateShrinkage
74         \@PBshrinkPage
75       }
76     }
77   }
78 }
79 {}
80 }
81
82 % Calculate how much we should shrink the left column of the last
83 % page based on the measurements we took on previous LaTeX passes.
84 \newcommand\@PBcalculateShrinkage{
85
86   % Let's use some shorter names, please
87   \dimdef\@PBtmpH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}Height}}
88   \dimdef\@PBtmpUL{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}UsedLeft}}
89   \dimdef\@PBtmpUR{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}UsedRight}}
90
91   \dimdef\@PBtmpLH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}LeftHeight}}
92   \dimdef\@PBtmpLFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}LeftFloatsHeight}}
93   \dimdef\@PBtmpRH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}RightHeight}}
94   \dimdef\@PBtmpRFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}RightFloatsHeight}}
95
96   % Figure out the amount of unused space on the last page (both
97   % cols); we will reduce the first column height by half that amount
98   \dimgdef\@PBslack{2\dimexpr\@PBtmpH\relax - \@PBtmpUL - \@PBtmpUR}
99   \dimgdef\@PBslack{.5\dimexpr\@PBslack\relax}
100
101   % Actually, I lied. While half, as said above, sometimes yields
102   % perfectly balanced columns, that is often not the case (the page
103   % may have an odd number of lines, or textheight may not be a
104   % multiple of baselineskip, or there may be glues etc.). Sometimes
105   % the difference is very small, less than a line, which does not
106   % look good at all, and sometimes the right column is slightly
107   % higher than the left, which is also not ideal. Here, we force
108   % the left column to always be somewhat taller than the left; the
109   % result is often "better".
110   \dimgdef\@PBslack{\@PBslack - 1.5\baselineskip}
111

```

```

112 % If necessary, reduce @PBslack to prevent LaTeX from adding a page
113 \@PBSafetyCheck
114 }
115
116 \def\@PBshrinkPage{
117 % Zero obviously means “do nothing”. We could
118 % “enlarge” by 0, but IDK, maybe that would
119 % trigger another LaTeX pass or something.
120 \ifdimcomp{\@PBslack}{=}{0pt}
121 {}
122 {
123 % Shrink the first column
124 \enlargethispage{-\@PBslack}
125
126 % Modify the behavior of \@outputdblcol
127 % to raise footnotes in the second column.
128 \global\let\@PBbalanceSecondColumn\@PBrealBalanceSecondColumn
129 }
130 }
131
132 % If there are footnotes on the right column, it is better to
133 % “push” them up to be aligned with the end of the left column,
134 % especially if there are footnotes on the left column too. We
135 % do this by manipulating \@textbottom in \@outputdblcol.
136 \pretocmd{\@outputdblcol}{\@PBbalanceSecondColumn}{\@PBbalanceSecondColumn}{\@PBbalanceSecondColumn}{}{}
137
138 \let\@PBbalanceSecondColumn\relax
139
140 \def\@PBrealBalanceSecondColumn{
141 \if@firstcolumn
142 % Affects the next column
143 \global\let\@PBorigtextbottom\@textbottom
144 \gdef\@textbottom{\vskip \@PBslack plus .0001fil minus 10000fil\relax \@PBorig-
textbottom}
145 \else
146 % Back to normal before starting the next page
147 \global\let\@textbottom\@PBorigtextbottom
148 \global\let\@PBbalanceSecondColumn\relax
149 \fi
150 }
151

```

4.3 The measuring front

For the mechanism above to work, we need to know:

1. The page number of the last page;
2. Whether the last page has floats, footnotes etc.;

3. The available height in the last page;
4. The height of the columns in the last page.

Let's collect this info for every page.

4.3.1 Are there floats, footnotes, or marginpars in the last page?

```

152
153 % To check whether there are floats etc. in the last page,
154 % we will copy the fancyhdr package:
155 % https://tex.stackexchange.com/questions/56673/is-there-a-way-to-determine-
    if-there-is-a-float-on-a-page
156 % But we add the tests to a different place.
157 \newcommand\@PBifmidfloat[2]{\ifx\@midlist\empty #2\else #1\fi}
158 \newcommand\@PBiftopfloat[2]{\ifx\@toplist\empty #2\else #1\fi}
159 \newcommand\@PBifbotfloat[2]{\ifx\@botlist\empty #2\else #1\fi}
160 \newcommand\@PBiffootnote[2]{\ifvoid\footins #2\else #1\fi}
161 \newcommand\@PBiffloatcol[2]{\if@fcolmade #1\else #2\fi}
162 % dbltop floats are apparently ok with the balance package
163 %%%\newcommand\@PBifdbltopfloat[2]{\ifx\@dbltoplist\empty #2\else #1\fi}
164 % dblbotlist only exists with package stfloats
165 \newcommand\@PBifdblbotfloat[2]{%
166   \ifdefvoid{\@dblbotlist}
167     {#2}
168     {\ifx\@dblbotlist\empty #2\else #1\fi}%
169 }
170
171 % If there are footnotes, floats or marginpars in
172 % the page, we should not use the balance package
173 \newtoggle{\@PBtmpHasFootnotes}
174 \newtoggle{\@PBtmpHasFloats}
175 \newtoggle{\@PBtmpHasMarginpars}
176
177 \def\@PBcollectPageInfo{
178
179   \ifboolexpr
180     {
181       test {\@PBifmidfloat} or test {\@PBiftopfloat} or
182       test {\@PBifbotfloat} or test {\@PBifdblbotfloat}
183     }
184     {\global\toggletrue{\@PBtmpHasFloats}}
185     {}
186
187   \@PBiffootnote
188     {\global\toggletrue{\@PBtmpHasFootnotes}}
189     {}
190 }
191
192 \pretocmd{\@makecol}{\@PBcollectPageInfo}{}{}

```

```

193
194 % This only gets called if there is a marginpar, so that's easy
195 \pretocmd{\@addmarginpar}{\global\toggletrue{@PBtmpHasMarginpars}}{}{}
196

```

4.3.2 What are the sizes of the floats in the left column?

```

197
198 \ExplSyntaxOn
199 \seq_gclear_new:N \@PBtmpLeftFloatHeights
200 \seq_gclear_new:N \@PBtmpLeftFloatSpacesBelow
201 \def\@PBcollectFloatHeights{
202   \if@firstcolumn
203     \dimdef\@PBfloatHeight{\@textfloatsheight - \@PBtmpHeightBefore}
204     \ifdimcomp{\@PBfloatHeight}{>}{0pt}
205       {
206         \global\seq_put_right:NV \@PBtmpLeftFloatHeights \@PBfloatHeight
207
208         \dimdef\@PBspaceBelow{\@colroom - \@pageht - \@PBfloatHeight}
209         % within \@addtocurcol, \@pageht corresponds to all
210         % currently used space in the column, including footnotes
211         % (check \@specialoutput in the LaTeX kernel). Let's
212         % exclude the footnotes, we only want the space below
213         % the float.
214         \ifvoid\footins\else
215           \dimdef\@PBspaceBelow{\@PBspaceBelow + \ht\footins + \skip\footins + \dp\footins}
216         \fi
217
218         % No idea why, but this can happen; maybe because of the page depth?
219         \ifdimcomp{\@PBspaceBelow}{<}{0pt}
220           {\dimdef\@PBspaceBelow{0pt}}
221         {}
222
223         \global\seq_put_right:NV \@PBtmpLeftFloatSpacesBelow \@PBspaceBelow
224       }
225     {}
226   \fi
227 }
228 \ExplSyntaxOff
229
230 \pretocmd{\@addtocurcol}{\dimdef{\@PBtmpHeightBefore}{\@textfloatsheight}}{}{}
231 \apptocmd{\@addtocurcol}{\@PBcollectFloatHeights}{}{}
232

```

4.3.3 What is the size of each column? Is there a float column / floatpage?

```

233
234 % If there is a float column in the page, it makes no sense to try to
235 % balance; if both columns are float columns, this page cannot be the
236 % final text page, i.e., we want to balance some other page.
237 \newtoggle{@PBtmpHasFloatcol}
238 \newtoggle{@PBtmpIsFloatPage}

```

```

239
240 \newcommand\@PBcollectColumnInfo{
241
242   \if@firstcolumn
243
244     \@PBiffloatcol
245     {\global\toggletrue{@PBtmpHasFloatcol}}
246     {}
247
248     % Available vertical space excluding
249     % dblfloats; the same for both columns
250     \dimdef\@PBtmpHeight{\@colht}
251
252     % Available vertical space excluding top/bottom floats
253     \dimdef\@PBtmpLeftHeight{\@colroom}
254
255     % Space used by \texttt{here} floats
256     \dimdef\@PBtmpLeftFloatsHeight{\@textfloatsheight}
257
258   \else
259
260     \@PBiffloatcol
261     {
262       \iftoggle{@PBtmpHasFloatcol}
263       {\global\toggletrue{@PBtmpIsFloatPage}}
264       {\global\toggletrue{@PBtmpHasFloatcol}}
265     }
266     {}
267
268     \dimdef\@PBtmpRightHeight{\@colroom}
269     \dimdef\@PBtmpRightFloatsHeight{\@textfloatsheight}
270
271     \setbox\@tempboxa=\copy\@leftcolumn
272     \setbox\@tempboxa=\vbox{\unvbox\@tempboxa\unskip\unskip}
273     \dimdef\@PBtmpUsedLeft{\ht\@tempboxa\relax}
274
275     \setbox\@tempboxa=\copy\@outputbox
276     \setbox\@tempboxa=\vbox{\unvbox\@tempboxa\unskip\unskip}
277     \dimdef\@PBtmpUsedRight{\ht\@tempboxa\relax}
278   \fi
279 }
280
281 % The default LaTeX macro
282 \pretocmd{\@outputdblcol}{\@PBcollectColumnInfo}{}{}
283
284 % The version from the balance package
285 \AtEndOfPackage{
286   \pretocmd{\@Adblcol}{\@PBcollectColumnInfo}{}{}
287   % Revert \balance before next page if it exists (it might be a float page)
288   \patchcmd{\@Adblcol}{\endgroup}{\endgroup\nobalance}{}{}

```

289 }

290

4.3.4 Analyze the obtained information

We have inserted the hooks we need to collect data during the processing of each page and column. Now we inspect the collected data after each page is finalized.

291

292 \ExplSyntaxOn

293 \AtBeginShipout{

294 \ifboolexpr

295 {

296 % A float page is not the last text page, ignore

297 togl {@PBtmpIsFloatPage}

298 or

299 % A page with a float column on the left and an empty

300 % column on the right is not the last text page, ignore

301 (

302 togl {@PBtmpHasFloatcol}

303 and

304 test {\ifdimcomp{\@PBtmpUsedRight}{=}{\topskip}}

305)

306 }

307 {}

308 {

309 % This page is a candidate to be the last page

310 \xdef{@PBlastPage}{\the\value{abspage}}

311 \@PBCopyPageData{tmp}{candidate}

312 }

313

314 % Reset before processing next page

315 \global\togglefalse{@PBtmpHasFloats}

316 \global\togglefalse{@PBtmpHasFloatcol}

317 \global\togglefalse{@PBtmpHasFootnotes}

318 \global\togglefalse{@PBtmpHasMarginpars}

319 \global\togglefalse{@PBtmpIsFloatPage}

320

321 \seq_gclear_new:N \@PBtmpLeftFloatHeights

322 \seq_gclear_new:N \@PBtmpLeftFloatSpacesBelow

323 }

324 \ExplSyntaxOff

325

All pages processed, the last candidate page is actually the last page. Instead of continuing to use the @PBcandidate* macros we already have, we will keep the information we just gathered associated with the page number. We do this because, in the future, we may want to add support for balancing multiple pages (such as the last page of each chapter) and not only the last one. This also makes it easier to handle the situation where the document was modified and the last page has changed.

326

```

327 \AfterLastShipout{\@PBcopyPageData{candidate}{pg\@Roman{\@PBlastPage}}}
328

```

4.3.5 Saving measurements

The whole document has already been processed and data about the last page has been collected in macros with names @PBpgNUM*. We now process this collected data and save whatever is relevant in the aux file for the next L^AT_EX pass.

In the first L^AT_EX pass, we will save data to the aux file in macros with names @PBunbalpgNUM*. That is all we need for balancing. However, to detect whether the document has changed and, therefore, whether we should re-balance, we will also record the same data after balancing (during the second pass) in macros with names @PBbalpgNUM*. If, in the third or later L^AT_EX passes, @PBbalpgNUM* differ from @PBpgNUM*, the document has been changed and we need to re-balance.

So, we have:

@PBpgNUM* data collected during the current pass;

@PBunbalpgNUM* data collected in the first pass;

@PBbalpgNUM* data collected in the second pass (after balancing); in subsequent passes, these should always be equal to @PBpgNUM*.

The last two are saved to / read from the aux file.

```

329
330 % Make sure the document has stabilized before using \@PBmanageBalancingPasses
331 \AfterLastShipout{
332   % Reset \@PBimpossible if we are in draft mode,
333   % so the user can start over if they want to.
334   \iftoggle{@PBdraft}{\togglefalse{@PBimpossible}}{}
335
336   \ifboolexpr{togl {@PBdraft} or togl {@PBimpossible}}
337     {}
338   {
339     \ifdefvoid{\@PBprevLastPage}
340       {\@PBsaveUnbalancedInfo\@PBnotifyRerun} % First pass
341     {
342       \iftoggle{@PBstabilized}
343         {\@PBmanageBalancingPasses}
344       {
345         \@PBifSomethingChanged[unbal]
346         % Document still changing; discard data from previous pass
347         {\@PBsaveUnbalancedInfo[update]\@PBnotifyRerun}
348         % No changes, so let's balance from now on (once @PBstabilized
349         % becomes true, it never reverts back to false, unless the aux
350         % file is deleted).
351         {\toggletrue{@PBstabilized}\@PBsaveUnbalancedInfo\@PBnotifyRerun}
352       }
353     }
354   }

```

```

354     \@PBsaveToggle{@PBstabilized}
355   }
356
357   \@PBsaveToggle{@PBimpossible}
358   \immediate\write\@mainaux{\gdef\string\@PBprevLastPhysPage{\the\value{abspage}}}
359 }
360
361 \newcommand\@PBmanageBalancingPasses{
362   % This is the second pass or later after we started balancing
363
364   \providetoggle{@PBpg\@Roman{\@PBlastPage}alreadyBalanced}
365
366   \iftoggle{@PBpg\@Roman{\@PBlastPage}alreadyBalanced}
367   {
368     % Third pass or later; document was already
369     % balanced, so there should be no more changes
370     \@PBifSomethingChanged
371     % The document has changed, so we need to measure
372     % stuff again; clear aux file and start over.
373     {\@PBnotifyRerun}
374     % Nothing changed, just write the same info down
375     {\@PBsaveUnbalancedInfo\@PBsaveBalancedInfo}
376   }
377   % Second pass, which means something did change: we have just
378   % balanced the columns for the first time.
379   {
380     \xdef\@tempa{\the\value{abspage}}
381     \ifboolexpr
382     {
383       test {\ifdefstrequal{\@PBprevLastPage}{\@PBlastPage}}
384       and
385       test {\ifdefstrequal{\@PBprevLastPhysPage}{\@tempa}}
386     }
387     % All is well; save the new info
388     {\@PBsaveUnbalancedInfo\@PBsaveBalancedInfo}
389     % Oh, no! As we attempted to balance, we actually changed
390     % the number of pages (maybe we added a float page, maybe
391     % we turned the last float page into a text page etc.). If
392     % we continue, the document might never converge (endless
393     % ‘‘please rerun LaTeX’’ messages). Let’s give up balancing.
394     {\toggletrue{@PBimpossible}}
395   }
396 }
397

```

4.4 Auxiliary macros

```

398
399 \newcommand\@PBifBalancePossible[2]{
400   \iftoggle{@PBunbalpg\@Roman{\@PBprevLastPage}HasFloatcol}

```

```

401     {#2}
402     {#1}
403 }
404
405 % The balance package may fail badly in the presence of footnotes:
406 % they may end up in the middle of the text. Marginpars may end up
407 % on the wrong side of the page. Floats are usually ok, but in some
408 % cases the columns may become very badly balanced. For ordinary
409 % text, it works perfectly.
410 \newcommand\@PBifBalancePkgPossible[2]{
411   \ifboolexpr
412   {
413     togl \@PBunbalpg\@Roman{\@PBprevLastPage}HasFloats}
414     or
415     togl \@PBunbalpg\@Roman{\@PBprevLastPage}HasFootnotes}
416     or
417     togl \@PBunbalpg\@Roman{\@PBprevLastPage}HasMarginpars}
418   }
419   {#2}
420   {#1}
421 }
422

```

We only want to balance if:

1. The left column is higher than the right one. If that is not the case, either things are already balanced or the right column is higher, which means \LaTeX was forced into a bad solution already.
2. This difference is “large enough” (6 lines), which means two things:
 - (a) There will be an actual improvement in the result.
 - (b) There is plenty of free space on the right column, so even if our changes happen to take more space than before, \LaTeX will hopefully not add a new page (but it might make the right column higher than the left, which is not so great).

If there is material only on the left column, we want to balance even if the difference in height is not “large enough”, as long as there are more than 4 lines to split among columns. This is actually quite unlikely: if there is so little material, the page probably has only normal text and we will use the balance package.

```

423
424 \newcommand\@PBifPoorBalancePossible[2]{
425
426   % Let's use some shorter names, please
427   \dimdef\@PBtmpH{\csuse{\@PBunbalpg\@Roman{\@PBprevLastPage}Height}}
428   \dimdef\@PBtmpUL{\csuse{\@PBunbalpg\@Roman{\@PBprevLastPage}UsedLeft}}
429   \dimdef\@PBtmpUR{\csuse{\@PBunbalpg\@Roman{\@PBprevLastPage}UsedRight}}
430
431   \dimdef\@PBtmpLH{\csuse{\@PBunbalpg\@Roman{\@PBprevLastPage}LeftHeight}}

```

```

432 \dimdef\@PBtmpLFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}LeftFloatsHeight}}
433 \dimdef\@PBtmpRH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}RightHeight}}
434 \dimdef\@PBtmpRFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}RightFloatsHeight}}
435
436 \ifboolexpr{
437   % Plenty of space on right column, difference is worth it
438   test {\ifdimcomp{\@PBtmpUL}{>}{\@PBtmpUR + 6\baselineskip}}
439   or
440   (
441     test {\ifdimcomp{\@PBtmpUL}{>}{4\baselineskip}}
442     and
443     test {\ifdimcomp{\@PBtmpUR}{=}{\topskip}} % column is empty
444   )
445 }{#1}{#2}
446 }
447

```

If there are floats, things can get messy: imagine that we want to shrink by 50pt, but there is a 250pt float near the end of the left column that won't fit after we shrink, so it will move to the right. What if there is no room for such a large float there? Here, we try to prevent this situation and shrink by a smaller amount if there is a float that won't fit. Note that, if the float goes to the right column, there will be more room for text in the left column. Therefore, a float will not fit only if the floats on the right column take too much space. So, what we do here is, starting from the bottom, check whether the accumulated height of the floats from the left column fit in the right. If we find a float that will not fit, we know that we should limit shrinking to the space below that float.

In the same vein, we do not want top/bottom floats from the left column that were deferred from a previous page to be pushed to the right column. To that end, we limit the shrinking amount to the space on the left column not taken by top/bottom floats.

TODO: Top and bottom floats may appear in two cases: (1) they were generated on a previous page and deferred or (2) the user chose placement options t or b, without h. Deferred floats are not a problem: we do not reduce the space available for top/bottom floats, so they should continue to fit. Floats on the left column with placement options t and b without h can be a problem: \LaTeX only considers putting a float on the top/bottom of the current column if, at the point of its definition, there is enough space for it. Since we are shrinking the column, it may not fit and be deferred - something the algorithm does not take into consideration. However, not all is lost: most likely, the user will only use such placement options when trying to manually adjust the page, which means they will be able to detect and work around eventual problems.

```

448
449 \ExplSyntaxOn
450 \def\@PBsafetyCheck{
451
452   % Let's use some shorter names, please
453   \dimdef\@PBtmpH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}Height}}
454   \dimdef\@PBtmpUL{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}UsedLeft}}
455   \dimdef\@PBtmpUR{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}UsedRight}}
456

```

```

457 \dimdef\@PBtmpLH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}LeftHeight}}
458 \dimdef\@PBtmpLFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}LeftFloatsHeight}}
459 \dimdef\@PBtmpRFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}RightHeight}}
460 \dimdef\@PBtmpRFH{\csuse{@PBunbalpg\@Roman{\@PBprevLastPage}RightFloatsHeight}}
461
462
463 % Make sure we do not push top/bottom floats out of the left col
464 \dimdef\@PBmaxSlack{\@PBtmpLH}
465
466 \dimdef\@PBtmpdim{0pt}
467
468 % Start from the bottom
469 \numdef{\@PBtmpcnt}{\seq_count:c {@PBunbalpg\@Roman{\@PBprevLastPage}LeftFloatHeights}}
470 \int_while_do:nNnn {\@PBtmpcnt} > {0}
471 {
472
473     \dimdef\@PBcurrentFloatHeight
474     {\seq_item:cn {@PBunbalpg\@Roman{\@PBprevLastPage}LeftFloatHeights} {\@PBtmp-
pcnt}}
475
476     \dimdef\@PBcurrentFloatSpaceBelow
477     {\seq_item:cn {@PBunbalpg\@Roman{\@PBprevLastPage}LeftFloatSpacesBelow} {\@PBtmp-
pcnt}}
478
479     \dimdef{\@PBtmpdim}{\@PBtmpdim + \@PBcurrentFloatHeight}
480
481     \ifboolexpr
482     {
483         % Does the float fit in the second column?
484         test {\ifdimcomp{\@PBtmpdim}{<}{\@PBtmpRH - \@PBtmpRFH}}
485         and
486         % Is there something above this float, i.e., if we move
487         % this float to the next column, will anything remain?
488         test
489         {
490             \ifdimcomp
491             {\@PBcurrentFloatSpaceBelow + \@PBcurrentFloatHeight}
492             {<}
493             {\@PBtmpLH - 6\baselineskip}
494         }
495     }
496     {\numdef{\@PBtmpcnt}{\@PBtmpcnt - 1}} % this one is ok; check next
497     {
498         % this one should not be moved, we found the limit
499         \ifdimcomp{\@PBmaxSlack}{>}{\@PBcurrentFloatSpaceBelow}
500         {\dimdef{\@PBmaxSlack}{\@PBcurrentFloatSpaceBelow}}
501         {}
502         \numdef{\@PBtmpcnt}{0} % exit the loop
503     }
504 }

```

```

505
506 \ifdimcomp{\@PBmaxSlack}{<}{\@PBslack}
507 {\dingdef{\@PBslack}{\@PBmaxSlack}}
508 {}
509 }
510 \ExplSyntaxOff
511
512 % Compare current measurements with previous ‘‘bal’’ or ‘‘unbal’’ measurements
513 \newcommand\@PBifSomethingChanged[3][bal]{
514 \ifdefstrequal{\@PBprevLastPage}{\@PBlastPage}
515 {
516 \@PBifPageDataMatches
517 {pg\@Roman{\@PBlastPage}}
518 {#1pg\@Roman{\@PBlastPage}}
519 {#3}
520 {#2}
521 }
522 {#2}
523 }
524
525 \newcommand\@PBifPageDataMatches[4]{
526 \ifboolexpr{
527 test {\@PBifTogglesMatch{\@PB#1HasFloats}{\@PB#2HasFloats}}
528 and test {\@PBifTogglesMatch{\@PB#1HasFloatcol}{\@PB#2HasFloatcol}}
529 and test {\@PBifTogglesMatch{\@PB#1HasFootnotes}{\@PB#2HasFootnotes}}
530 and test {\@PBifTogglesMatch{\@PB#1HasMarginpars}{\@PB#2HasMarginpars}}
531 and test {\@PBifDimensionsMatch{\@PB#1Height}{\@PB#2Height}}
532 and test {\@PBifDimensionsMatch{\@PB#1LeftHeight}{\@PB#2LeftHeight}}
533 and test {\@PBifDimensionsMatch{\@PB#1RightHeight}{\@PB#2RightHeight}}
534 and test {\@PBifDimensionsMatch{\@PB#1UsedLeft}{\@PB#2UsedLeft}}
535 and test {\@PBifDimensionsMatch{\@PB#1UsedRight}{\@PB#2UsedRight}}
536 }
537 {#3}
538 {#4}
539 }
540
541 % https://en.wikipedia.org/wiki/XNOR\_gate
542 \newcommand\@PBifTogglesMatch[4]{
543 \ifboolexpr{(togl{#1} or not togl{#2}) and (togl{#2} or not togl{#1})}
544 {#3}
545 {#4}
546 }
547
548 \newcommand\@PBifDimensionsMatch[4]{
549 \ifdimcomp{\csuse{#1}}{=}{\csuse{#2}}
550 {#3}
551 {#4}
552 }
553
554 \newcommand\@PBsaveUnbalancedInfo[1][] {

```

```

555
556 \immediate\write\@mainaux{\gdef\string\@PBprevLastPage{\@PBlastPage}}
557
558 \ifboolexpr{test {\ifdefvoid{\@PBprevLastPage}} or test {\ifstrequal{#1}{update}}}{
559   % Columns are currently unbalanced, either because this is
560   % the first pass (we do not have any previous information)
561   % or because the document has not stabilized yet, so any
562   % previous information is unreliable. Save the information
563   % we just collected as ‘unbalanced’.
564   {\@PBsavePageDataAs{pg\@Roman{\@PBlastPage}}{unbalpg\@Roman{\@PBlastPage}}}
565   % Not the first pass, so columns are possibly balanced;
566   % to save the unbalanced information, repeat what was
567   % gathered during the first pass.
568   {\@PBsavePageData{unbalpg\@Roman{\@PBprevLastPage}}}
569 }
570
571 \def\@PBsaveBalancedInfo{
572   \global\toggletrue{\@PBpg\@Roman{\@PBlastPage}alreadyBalanced}
573   \@PBsaveToggle{\@PBpg\@Roman{\@PBlastPage}alreadyBalanced}
574
575   \@PBsavePageDataAs{pg\@Roman{\@PBlastPage}}{balpg\@Roman{\@PBlastPage}}
576 }
577
578 \def\@PBnotifyRerun{
579   \AtVeryEndDocument{
580     \PackageWarningNoLine{pbalance}
581     {Last page columns not balanced. Rerun LaTeX}
582   }
583 }
584
585 \ExplSyntaxOn
586 \newcommand\@PBcopyPageData[2]{
587
588   \global\providetoggle{\@PB#2HasFloats}
589   \global\providetoggle{\@PB#2HasFloatcol}
590   \global\providetoggle{\@PB#2HasFootnotes}
591   \global\providetoggle{\@PB#2HasMarginpars}
592
593   \iftoggle{\@PB#1HasFloats}
594     {\global\toggletrue{\@PB#2HasFloats}}
595     {\global\togglefalse{\@PB#2HasFloats}}
596
597   \iftoggle{\@PB#1HasFloatcol}
598     {\global\toggletrue{\@PB#2HasFloatcol}}
599     {\global\togglefalse{\@PB#2HasFloatcol}}
600
601   \iftoggle{\@PB#1HasFootnotes}
602     {\global\toggletrue{\@PB#2HasFootnotes}}
603     {\global\togglefalse{\@PB#2HasFootnotes}}
604

```

```

605 \iftoggle{@PB#1HasMarginpars}
606   {\global\toggletrue{@PB#2HasMarginpars}}
607   {\global\togglefalse{@PB#2HasMarginpars}}
608
609 \csdimgdef{@PB#2Height}{\csuse{@PB#1Height}}
610 \csdimgdef{@PB#2LeftHeight}{\csuse{@PB#1LeftHeight}}
611 \csdimgdef{@PB#2LeftFloatsHeight}{\csuse{@PB#1LeftFloatsHeight}}
612 \csdimgdef{@PB#2RightHeight}{\csuse{@PB#1RightHeight}}
613 \csdimgdef{@PB#2RightFloatsHeight}{\csuse{@PB#1RightFloatsHeight}}
614 \csdimgdef{@PB#2UsedLeft}{\csuse{@PB#1UsedLeft}}
615 \csdimgdef{@PB#2UsedRight}{\csuse{@PB#1UsedRight}}
616
617 \seq_gclear_new:c {@PB#2LeftFloatHeights}
618 \seq_gclear_new:c {@PB#2LeftFloatSpacesBelow}
619 \seq_gset_eq:cc {@PB#2LeftFloatHeights} {@PB#1LeftFloatHeights}
620 \seq_gset_eq:cc {@PB#2LeftFloatSpacesBelow} {@PB#1LeftFloatSpacesBelow}
621 }
622 \ExplSyntaxOff
623
624 \newcommand\@PBsavePageDataAs[2]{
625   \@PBsaveDimAs{@PB#1Height}{@PB#2Height}
626   \@PBsaveDimAs{@PB#1LeftHeight}{@PB#2LeftHeight}
627   \@PBsaveDimAs{@PB#1LeftFloatsHeight}{@PB#2LeftFloatsHeight}
628   \@PBsaveDimAs{@PB#1RightHeight}{@PB#2RightHeight}
629   \@PBsaveDimAs{@PB#1RightFloatsHeight}{@PB#2RightFloatsHeight}
630   \@PBsaveDimAs{@PB#1UsedLeft}{@PB#2UsedLeft}
631   \@PBsaveDimAs{@PB#1UsedRight}{@PB#2UsedRight}
632
633   \@PBsaveToggleAs{@PB#1HasFloats}{@PB#2HasFloats}
634   \@PBsaveToggleAs{@PB#1HasFloatcol}{@PB#2HasFloatcol}
635   \@PBsaveToggleAs{@PB#1HasFootnotes}{@PB#2HasFootnotes}
636   \@PBsaveToggleAs{@PB#1HasMarginpars}{@PB#2HasMarginpars}
637
638   \@PBsaveSeqAs{@PB#1LeftFloatHeights}{@PB#2LeftFloatHeights}
639   \@PBsaveSeqAs{@PB#1LeftFloatSpacesBelow}{@PB#2LeftFloatSpacesBelow}
640 }
641
642 \newcommand\@PBsavePageData[1]{
643   \@PBsavePageDataAs{#1}{#1}
644 }
645
646 \newcommand\@PBsaveToggleAs[2]{
647   \immediate\write\@mainaux{\providetoggle{#2}}
648   \iftoggle{#1}
649     {\immediate\write\@mainaux{\global\toggletrue{#2}}}
650     {\immediate\write\@mainaux{\global\togglefalse{#2}}}
651 }
652
653 \newcommand\@PBsaveToggle[1]{
654   \@PBsaveToggleAs{#1}{#1}

```

```

655 }
656
657 \newcommand\@PBsaveDimAs[2]{
658   \immediate\write\@mainaux{\csdingdef{#2}{\csuse{#1}}}
659 }
660
661 \newcommand\@PBsaveDim[1]{
662   \@PBsaveDimAs{#1}{#1}
663 }
664
665 \ExplSyntaxOn
666 \newcommand\@PBsaveSeqAs[2]{
667   \immediate\write\@mainaux{\string\ExplSyntaxOn}
668   \immediate\write\@mainaux{\string\seq_gclear_new:c {#2}}
669   \seq_map_inline:cn {#1}
670     {\immediate\write\@mainaux{\string\global\string\seq_put_right:cn {#2}{##1}}}
671   \immediate\write\@mainaux{\string\ExplSyntaxOff}
672 }
673 \ExplSyntaxOff
674
675 \newcommand\@PBsaveSeq[1]{
676   \@PBsaveSeqAs{#1}{#1}
677 }
678

```